IN THE CLAIMS:

1. A method for ~~differentiating if~~ detecting collisions ~~a feedback signal is a result of an unintentional collision in a servo system,~~ between an obstacle and an electromechanical system having a mechanical output controlled by a servo system, said method ~~comprising~~ comprising:

inputting a forcing function x_i to the servo system to direct the mechanical output to move in an intended manner;

generating a difference signal at a monitoring point M representing a difference between forcing function x_i and a feedback signal dependent upon the mechanical output;

injecting a feed forward ~~term in the servo system.~~ signal into the servo system, said feed forward signal dependent upon the forcing function and effective to increase a detection threshold for collision stimulus at monitoring point M; and

processing said difference signal to detect a collision.

2. (cancelled)

3. (cancelled)

4. (currently amended) A method in accordance with ~~Claim 1~~ Claim 21 ~~further comprising optimizing~~ wherein said optimizing transfer function y_o/x_2 comprises optimizing y_o/x_2 without the influence of the feed forward signal. ~~forward, wherein x_2 is a load function and y_o is an output of the servo system.~~

5. (cancelled)

6. (cancelled)

7. (currently amended) An imaging system comprising:

a radiation source;

a radiation detector positioned to receive radiation emitted by said source;

a servo system configured to position at least one of said source, said detector, and an object to be scanned; and

said imaging system configured to input a forcing function x_i to the servo system to direct at least one of said source, said detector, and said object to be scanned to move in an intended manner; generate a difference signal at a monitoring point M representing a difference between forcing function x_i and a feedback signal dependent upon a mechanical output; injecting a feed forward signal in said servo system, said feed forward signal dependent upon the forcing function and effective to increase a detection threshold for collision stimulus at monitoring point M; and process said difference signal to detect a collision.

~~a computer operationally coupled to said source, said detector, and said servo system, said computer configured to inject a feed forward term in said servo system.~~

8. (cancelled)

9. (cancelled)

10. (cancelled)

11. (cancelled)

12. (currently amended) A system in accordance with ~~Claim 9~~ Claim 32 wherein said computer further configured to optimize y_o/x_2 without the influence of the feed forward signal. ~~forward, wherein x_2 is a load function.~~

13. (cancelled)

14. (cancelled)

15. (cancelled)

16. (cancelled)

17. (cancelled)

18. (cancelled)

19. (currently amended) A method of ~~configuring~~ operating a servo system ~~with~~ having an initial aggressiveness level for responding to a collision and a desired aggressiveness level for responding to an input control signal, said method comprising:

reducing the initial aggressiveness level for responding ~~to a~~ to the collision; and

maintaining the desired aggressiveness level for responding to the input.

20. (original) A method in accordance with Claim 19 wherein the servo system includes a feedback system, said reducing the initial aggressiveness level comprises reducing the initial aggressiveness level by optimizing the feedback system for collisions.

21. (original) A method in accordance with Claim 20 wherein said maintaining the desired aggressiveness level for responding to the input comprises maintaining the desired aggressiveness level for responding to the input by providing a feed forward term to the servo system.

22. (new) A method in accordance with Claim 1 further comprising optimizing a transfer function y_o/x_2, wherein y_o is a signal representative of the mechanical output and x_2 is a load function.

23. (new) A method in accordance with Claim 22 wherein said feed forward signal dependent upon the forcing function is selected to also optimize a transfer function y_o/x_i.

24. (new) A method in accordance with Claim 21 wherein said feed forward signal is injected into a plurality of points in the servo system.

25. (new) A method in accordance with Claim 1 further comprising initiating a command to stop movement when a collision is detected.

26. (new) An apparatus comprising:

a servo system;

an electromechanical system having a mechanical output controlled by said servo system;

said servo system configured to input a forcing function x_i to the servo system to direct the mechanical output to move in an intended manner, generate a difference signal at a monitoring point M representing a difference between forcing function x_i and a feedback signal dependent upon said mechanical output, and inject a feed forward signal into the servo system, said feed forward signal dependent upon the forcing function and effective to increase a detection threshold for collision stimulus at monitoring point M; and

said apparatus further configured to process said difference signal to detect a collision.

27. (new) An apparatus in accordance with Claim 26 further configured to optimize a transfer function y_o/x_2 of the servo system, wherein y_o is signal representative of said mechanical output and x_2 is a load function.

28. (new) An apparatus in accordance with Claim 27 wherein said feed forward signal dependent upon the forcing function is selected to also optimize a transfer function y_o/x_i.

29. (new) An apparatus in accordance with Claim 27 wherein y_o/x_2 is optimized without the influence of the feed forward signal.

30. (new) An apparatus in accordance with Claim 26 configured to inject said feed forward signal into a plurality of points in said servo system.

31. (new) An apparatus in accordance with Claim 26 further configured to initiate a command to stop movement when a collision is detected.

32. (new) A system in accordance with Claim 7 further configured to optimize a transfer function y_o/x_2 of the servo system, wherein y_o is signal representative of said mechanical output and x_2 is a load function.

33. (new) A system in accordance with Claim 32 wherein said feed forward signal dependent upon the forcing function is selected to also optimize a transfer function y_o/x_i.

34. (new) A system in accordance with Claim 7 configured to inject said feed forward signal into a plurality of points in said servo system.

35. (new) A system in accordance with Claim 7 further configured to initiate a command to stop movement when a collision is detected.

IN THE ABSTRACT:

Please replace the Abstract on Page 18 of the originally filed Application with the Abstract on the separate page attached to this Amendment. For convenience, a copy of the new Abstract showing the changes introduced by this replacement is provided below.

A method for ~~differentiating if a feedback signal is a result of an unintentional collision in a servo system includes~~ detecting collisions between an obstacle and an electromechanical system having a mechanical output controlled by a servo system includes inputting a forcing function x_i to the servo system to direct the mechanical output to move in an intended manner. A difference signal is generated at a monitoring point M representing a difference between forcing function x_i and a feedback signal dependent upon the mechanical output. The method further includes injecting a feed forward ~~term in~~ signal into the servo system. The feed forward signal is dependent upon the forcing function and effective to increase a detection threshold for collision stimulus at monitoring point M. The method also includes processing the difference signal to detect a collision.

A method for detecting collisions between an obstacle and an electromechanical system having a mechanical output controlled by a servo system includes inputting a forcing function x_i to the servo system to direct the mechanical output to move in an intended manner. A difference signal is generated at a monitoring point M representing a difference between forcing function x_i and a feedback signal dependent upon the mechanical output. The method further includes injecting a feed forward signal into the servo system. The feed forward signal is dependent upon the forcing function and effective to increase a detection threshold for collision stimulus at monitoring point M. The method also includes processing the difference signal to detect a collision.

IN THE SPECIFICATION:

Note: In the following replacements, tables and equations appearing on separate lines are considered to be part of the last-numbered paragraph above the table or equations if the tables or equations are not denoted by a separate paragraph number in brackets in the original specification. Therefore, these tables and equations are reproduced in the substitution paragraphs below even if no changes are to be made within the tables and equations.

Because of the difficulty of using the standard typographical conventions of underlining, strikethrough, and double brackets for indicating amendments to tables and equations and the probable confusion that would result, any amendments to tables or equations are specifically cited in the italicized notes above the paragraphs rather than indicated by these typographical conventions.

Please replace paragraph [0028] of the specification with the following amended paragraph of the same number:

[0028] G_1 can be chosen to make y_o/x_2 behave optimally for collision detection and avoidance. An alternative version of G_1 is selected and defined as G_1', which is chosen to ~~make y_o/x_i behave~~ make y_o/x_2 behave optimally from the point of view of the forcing function x_i but without using feed forward ($F_1 = 0$). The alternative versions for G_1 and G_1' are indicated as option 1 and option 2 in Figure 3, where, in option 1, F_2=1 and in option 2, F_1=0. Finally, using G_1 and F_1 (but not G_1'), require a transfer function ~~for y_o/x_i that~~ for y_o/x_2 that behaves identically to the prior y_o/x_i, and solve for the required F_1 to force this result. The following equations show this process.

$$2)\ \frac{(F_1+1)G_1G_2}{1+G_1G_2H} = \frac{G_1'G_2}{1+G_1'G_2H}$$

Solving for F_1:

$$3)\ F_1 = \frac{G_1'(1+G_1G_2H) - G_1(1+G_1'G_2H)}{G_1(1+G_1'G_2H)}$$

Please replace paragraph [0030] of the specification with the following amended paragraph of the same numbers, further noting that each and every occurrence of the variable "F" inside equation 4) is changed to "F_1" (there were no occurrences of "F_1" in these equations as originally filed):

[0030] Figure 4 illustrates a specific example of an electromechanical servos system shown generically in Figure 3. In Figure 4, Kcount is motor amplifier gain. K_3/s is quadrature rotary gain (with N slits), K_m corrects gain applied to the output via a lead screw. K_1, K_2, and P_2 are motor parameters. Other values are chosen with programming. The closed loop response for Figure 4 inputs x_i and x_2 are given

$$4)\ y_0 = x_i \frac{(F_1+1)\frac{K_2K_3K_5}{Z_5Z_6}s^2+(F_1+1)\left(\frac{1}{Z_5}+\frac{1}{Z_6}\right)K_2K_3K_5s+(F_1+1)K_2K_3K_5}{\frac{1}{P_2P_6}s^4+\left(\frac{1}{P_2}+\frac{1}{P_6}\right)s^3+\left(\frac{K_2K_3K_4K_5}{Z_5Z_6}+1\right)s^2+\left(\frac{1}{Z_5}+\frac{1}{Z_6}\right)K_2K_3K_4K_5s+K_2K_3K_4K_5}$$

$$-x_2\frac{\frac{K_1K_3}{P_6}s^2+K_1K_3s}{\frac{1}{P_2P_6}s^4+\left(\frac{1}{P_2}+\frac{1}{P_6}\right)s^3+\left(\frac{K_2K_3K_4K_5}{Z_5Z_6}+1\right)s^2+\left(\frac{1}{Z_5}+\frac{1}{Z_6}\right)K_2K_3K_4K_5s+K_2K_3K_4K_5}$$

Please replace paragraph [0031] of the specification with the following amended paragraph of the same numbers, further noting that each and every occurrence of the variable "F" inside equations 7), 8), 9), and 10) is changed to "F_1" (there were no occurrences of "F_1" in these equations as originally filed):

[0031] Next, for y_o/x_i preferred terms K'_5 and Z'_5 are selected instead of K_5 and Z_5. ~~With no feed forward (F =0) this result in:~~ With no feed forward (F_1=0), this results in:

$$5)\quad \frac{y_0}{x_i}=\frac{\dfrac{K_2K_3K_5'}{Z_5'Z_6}s^2+\left(\dfrac{K_5'}{Z_5'}+\dfrac{K_5'}{Z_6}\right)K_2K_3s+K_2K_3K_5'}{\dfrac{1}{P_2P_6}s^4+\left(\dfrac{1}{P_2}+\dfrac{1}{P_6}\right)s^3+\left(\dfrac{K_2K_3K_4K_5'}{Z_5'Z_6}+1\right)s^2+\left(\dfrac{1}{Z_5'}+\dfrac{1}{Z_6}\right)K_2K_3K_4K_5's+K_2K_3K_4K_5'}$$

From inspection of Figure 4 it is clear that $6)\ M = x_i - y_0K_4$

~~F can be determined~~ F1 can be determined using equation 3) to obtain equation 7).

$$7)\quad F_1=\frac{K_5'\,\dfrac{\frac{s}{Z_5'}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\left(1+K_5\times\dfrac{\frac{s}{Z_5}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\dfrac{1}{\frac{s}{P_2}+1}\times\dfrac{K_3}{s}\times K_4\right)-K_5\times\dfrac{\frac{s}{Z_5}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\left(1+K_5'\times\dfrac{\frac{s}{Z_5'}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\dfrac{1}{\frac{s}{P_2}+1}\times\dfrac{K_3}{s}\times K_4\right)}{K_5\times\dfrac{\frac{s}{Z_5}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\left(1+K_5'\times\dfrac{\frac{s}{Z_5'}+1}{s}\times\dfrac{\frac{s}{Z_6}+1}{\frac{s}{P_6}+1}\times K_2\times\dfrac{1}{\frac{s}{P_2}+1}\times\dfrac{K_3}{s}\times K_4\right)}$$

Rearranging equation 7), one obtains 8)

8)

$$F_1=\frac{\left(\dfrac{K_2K_5'}{Z_5'Z_6}s^2+\left(\dfrac{1}{Z_5'}+\dfrac{1}{Z_6}\right)K_2K_5's+K_2K_5'\right)\left(\dfrac{1}{P_2P_6}s^4+\left(\dfrac{1}{P_2}+\dfrac{1}{P_6}\right)s^3+\left(\dfrac{K_2K_3K_4K_5}{Z_5Z_6}+1\right)s^2+\left(\dfrac{1}{Z_5}+\dfrac{1}{Z_6}\right)K_2K_3K_4K_5s+K_2K_3K_4K_5\right)-\left(\dfrac{K_2K_5}{Z_5Z_6}s^2+\left(\dfrac{1}{Z_5}+\dfrac{1}{Z_6}\right)K_2K_5s+K_2K_5\right)\left(\dfrac{1}{P_2P_6}s^4+\left(\dfrac{1}{P_2}+\dfrac{1}{P_6}\right)s^3+\left(\dfrac{K_2K_3K_4K_5'}{Z_5'Z_6}+1\right)s^2+\left(\dfrac{1}{Z_5'}+\dfrac{1}{Z_6}\right)K_2K_3K_4K_5's+K_2K_3K_4K_5'\right)}{\left(\dfrac{K_2K_5}{Z_5Z_6}s^2+\left(\dfrac{1}{Z_5}+\dfrac{1}{Z_6}\right)K_2K_5s+K_2K_5\right)\left(\dfrac{1}{P_2P_6}s^4+\left(\dfrac{1}{P_2}+\dfrac{1}{P_6}\right)s^3+\left(\dfrac{K_2K_3K_4K_5'}{Z_5'Z_6}+1\right)s^2+\left(\dfrac{1}{Z_5'}+\dfrac{1}{Z_6}\right)K_2K_3K_4K_5's+K_2K_3K_4K_5'\right)}$$

For simplification, a change of notation is used, referencing equation 8).

$$9)\quad F_1=\frac{(As^2+Bs+C)(Ds^4+Es^3+Ps^2+Gs+H)-(Is^2+Js+K)(Ds^4+Es^3+Ls^2+Ms+N)}{(Is^2+Js+K)(Ds^4+Es^3+Ls^2+Ms+N)}$$

Finally,

$$10)\ F_1 = \frac{(AD\text{-}ID)s^6 + (AE+BD\text{-}IE\text{-}JD)s^5 + (AP+BE+CD\text{-}IL\text{-}JE\text{-}KD)s^4 + (AG+BP+CE\text{-}IM\text{-}JL\text{-}KE)s^3 + (AH+BG+CP\text{-}IN\text{-}JM\text{-}KL)s^2 + (BH+CG\text{-}JN\text{-}KM)s + CH\text{-}KN}{IDs^6 + (IE+JD)s^5 + (IL+JE+KD)s^4 + (IM+JL+KE)s^3 + (IN+JM+KL)s^2 + (JN+KM)s + KN}$$

Please replace paragraph [0032] of the specification with the following amended paragraph of the same numbers:

[0032] For the example application, the loop gain Bode plot that is optimized for x_i is given in Figure 5 with associated optimized parameters listed in Table 1. Note, the loop gain Bode plot in Figure 5 was optimized for x_i using K_5' and Z_5'. Because of the feed forward ~~parameter F~~ parameter F_1 (equation 10), this plot's phase margin can be used to predict the transient response of y_o/x_i . Note that for true stability, a Bode plot using K_5 and Z_5 (not K_5' and Z_5') can be used.

System Parameters	Servo Inputs	Calculations	
Kcomp =	0.07	Tm =	0.086
K4 =	1	K5' =	0.0060 20
Z5' =	5	P2 =	11.655
Tsample period =	0.002	Z6 =	11.656
Tcomp time =	0.002	K2 =	41.841
w start =	0.1	K1 =	2626.0 04
Scale Factor =	1.2	K3 =	318.31 0
Quad Enc Slits =	500	Km =	1.000
R =	1.5	Kloop@1r =	80.177
Ke =	0.0239		
J =	3.27E-05		
Kcount =	0.086		
Kleadscrew =	318.31		

Table 1

Please replace paragraph [0034] of the specification with the following amended paragraph of the same numbers:

[0034] For an actual system represented by the example application, some blocks of Figure 4 (including ~~the F term~~ the F_1 term given in equation 10) could be implemented in a computer and those functions accomplished via software programming using z-transforms of the Laplace equations. Other parts of the system can be realized in the form of electronic circuitry, an electric motor, and mechanical drive parts and other physical mechanisms. By proper use of equations 4), 5), and 6) a simulation of responses for the example application can be obtained, as though the feed forward term defined in equation 10) had been applied to an actual servo system.